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## Disposal of glass containers using fusing technology

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## Disposal of glass containers using fusing technology

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**Abstract.** Recently, glass containers are considered to be the most environmentally friendly for placing and storing products compared to plastic dishes. Therefore, the volume of consumption of products from glass containers is increasing, which requires resolving issues of its disposal or processing. The study proposed an alternative method for recycling glass containers, which allows you to efficiently recycle glass containers in order to reduce its emissions into the environment and harm the environment in general.

### 1. Introduction

Household waste is one of the categories of human waste. Collection and subsequent disposal of recycling and separation of materials are critical components in minimizing solid waste and help conserve natural resources, maintain a healthier environment and reduce greenhouse gas emissions [1]. About 75% of all glass entering the market as a packaging material is subject to return, and 25% is non-return [2]. According to scientists, numerous plastic compositions containing polyethylene, polystyrene, PVC, ABS, nylon, polypropylene, with different particle morphology and a narrow range of sizes and size distributions, were mixed with a similar size of brown glass into “fiberglass” composites having a glass composition 15, 30 and 45 percent of the mass. These prototypes were cast in a shape similar to standard clay bricks at 235 °C and underwent compression tests to more than double the fracture stress of clay bricks at temperatures between 20 and 50 °C. These prototypes illustrate the promise of utilizing waste plastics and glass in simple commercial materials and alleviating land filling problems that are now widespread throughout the world [3]. The best way to deal with the negative effects of glass waste, according to a group of scientists, is to reuse it. Recycling this waste, mainly from glass bottles and flat glasses, will be beneficial in conserving the earth's natural resources, reducing landfills and saving energy and money [4-7].

The production of glass foams is essentially a way to recycle glass [8-9]. Glass containers are classified as waste and a growing body of research on this issue confirms their impact on the quality of the environment. Therefore, it is a complex problem, especially in urban areas. Although it is recommended to limit the consumption of energy and natural raw materials, the use of scrap glass in the manufacture of new glass products is only possible after an expensive sorting step aimed at separating the glass from other materials such as metallic or ceramic impurities. This separation results in a fraction of almost pure glass ready for industry and a fraction enriched in pollutants, which remains practically unemployed and is mainly disposed of in landfills [10]. According to a group of scientists, under hydrothermal conditions of 30-40 MPa and 200-300 °C with H<sub>2</sub>O, glass powders can be sintered to form hardened glass materials containing about 10% of the mass of H<sub>2</sub>O. When the glass



containing H<sub>2</sub>O is reheated under normal pressure, the glass expands, releasing H<sub>2</sub>O, forming a porous microstructure. This glass can be used in filters to remove impurities from polluted air and water or in insulators to control heat transfer [11-12]. One of the alternative solutions for glass container processing is the use of new technologies. The demand for fusing is based not only on the magnificent decorative effects that technology allows to achieve, but also the practicality of sintered glass products is confirmed by a very attractive quality. Exposure to moisture, temperature drops, unfavorable environmental conditions does not affect fusing stained glass.

In addition, glass fusing can take almost any shape.

There are some processes that are used to modify glass for specific purposes, such as thin film coatings for solar radiation control and tempering, laminating for safety glass. Optical fibers must meet stringent quality requirements [13]. It is necessary to understand these requirements in order to know why complex processing techniques are needed.

Recycling refers to the various ways in which we recycle and reuse products, from household waste to recycling and reuse of various types of products and packaging materials. All these forms of processing pursue the same goal - the creation of conditions and opportunities for the survival of society [14].

According to scientists, more than half of the entire world ceramics market is made of glass, which is more than \$50 billion per year [15-17].

Glass recycling is necessary for:

- Reducing greenhouse gas emissions, i.e. CO<sub>2</sub>, for example, in the production of glass containers, the amount of greenhouse gas emissions in the atmosphere is reduced by 5% if 10% glass chips are used as raw materials.
- Reducing energy consumption, the production of 1 ton of glass from sand, soda and other material requires 3 times more energy than from used glass.
- An infinite number of times recycled material, and the quality of glass during processing does not deteriorate.
- The most resource-efficient packaging material because glass production has a large amount of ready-to-use raw material and does not require fossil fuel to clean the material.

Thus, the purpose of this study was to assess the categories of glass containers handed over by the population at reception points, as well as to propose alternative technologies for the disposal of glass containers in order to ensure the reduction of household waste and harm to the environment and human health.

## **2. Materials and methods**

When developing a general methodological framework, the guidelines for the collection of glass containers were used in accordance with TR CU 005/2011 Technical Regulations of the Customs Union "On the safety of packaging". Sampling was carried out by the same group throughout the study to ensure the objectivity of the sample.

In total, 3 glass container collection points were examined over the six-month period from January to June 2020. At each point, glass containers were collected on a quarterly basis, 4 times in 3 months.

Glass fusing technology is in great demand in modern decorating and design art. Like the classic stained glass window, fusing decor finds its application in window panes, double-glazed windows, door structures, interior partitions, niches, in the design of winter gardens, shop windows, pavilions, ceiling inserts and even shower cabins. Decorative panels and false windows look great in this technique. Due to the plasticity of fused glass, fusing is simply irreplaceable in the decoration of exclusive pieces of furniture, in the manufacture of designer vases, creative glass sculptures, etc.

### 3. Results

The number of glass containers by category in the surveyed areas is shown in table 1. Bottles for alcoholic beverages (57.23%), soft drinks (21.5%) and milk, fermented milk drinks (8.5%) were, respectively, the most a common category. Sauce products (5.5%) were the fourth most common glass containers, followed by baby food (3.9%) and cosmetic products (3.1%).

**Table 1.** Collection of glass containers by category for 6 months.

Plot No.	Categories of glass containers, pcs						
	Alcoholic beverages	Cold drinks	Milk and fermented milk drinks	Sauce products	Children food	Cosmetic products	Others
Central market	750045	40650	14900	10350	6800	5645	570
Aigul market	527956	33276	12920	8360	5928	4712	456
Yrtsy market	346550	26500	11600	6800	4235	3800	360
Average value by markets, pcs.	541517	33475	13140	8503	5654	4719	462
Average of the total volume, %	57.2	21.5	8.5	5.5	3.9	3.1	0.3

The composition, abundance, and distribution of the glass container category varied between study sites. Basically, bottles and cans were handed over for recycling, the rest of the categories of glass containers were used using fusing technology. To use this technology, you need a mini-oven for fusing and glass containers (table 2).

**Table 2.** Processing of glass containers using fusing technology.

Glass container category	Receiving glass breakage, kg	Receiving new exclusive tableware, pcs
Milk and fermented milk drinks	263	2-3
Sauce products	170	1-2
Children food	255	2-3
Cosmetic products	165	1-2
Others	9	1

### 4. Discussion

Undoubtedly, an important property of glass obtained using this technology is its strength, which exceeds the strength of conventional glass products by four times. This effect is achieved by heating the glass to high temperatures, which is actually tempering. And if such glass is nevertheless broken, then it will disintegrate into very small fragments that cannot cause dangerous wounds. As a result, we get a design that is safer in every sense.

In total, during the study (from January to June 2020), 1,075,000 glass containers were collected. The abundance of all glass containers varied between and within the three surveyed sites.

At the time of this study, the main categories of glass containers were containers for alcoholic beverages, soft drinks, milk and lactic acid drinks, sauce products, baby food, cosmetic products, and others.

### 5. Conclusion

Thus, according to the results of the study, the following conclusions can be drawn:

- In the context of this study, we are inclined to believe that new technologies for processing waste, in particular, glass containers, are effective and in demand. City dwellers are quite willing to hand over glassware at glass container collection points, which also helps to reduce environmental pollution;
- We have also concluded that collection points for glass containers are preliminary indications of the most commonly used categories of glass containers;
- The results of the study showed that the problem of glass recycling is amenable to solution and the application of preventive measures, accompanied by awareness-raising activities and investments in glass recycling, will further improve and maintain the current state of environmental cleanliness.

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